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HERRING OF THE OUTER SCOTIAN SHELF AND GEORGES BANK: HISTORY OF THE FISHERIES, RECENT DEVELOPMENTS AND MANAGEMENT CONSIDERATIONS

by

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ABSTRACT

Offshore banks of NAFO Subareas 4 and 5 have, in the past, supported significant herring fisheries. In recent years, larger vessels of the Scotia-Fundy purse seine fleet have made occasional trips to offshore banks to search for herring that may be of different stock origin to that of the usual 4WX fishery. In 1986, several significant findings were made, including spawning fish on both Western and Georges Banks.

This paper summarizes information from offshore banks of the Scotian Shelf and Georges Bank, including historical landings and recent data from research surveys and the commercial fleet.

RÉSUMÉ

Dans le passé, les bancs au large des sous-zones 4 et 5 de l'OPANO ont été une composante importante de la pêche au hareng. Au cours des dernières années, des bateaux plus gros de la flotte de pêche à la senne coulissante de Scotia-Fundy ont fait des sorties occasionnelles dans les bancs au large à la recherche de harengs provenant d'un stock différent de celui qui peuple la zone de pêche habituelle de 4WX. En 1986, on a fait quelques découvertes importantes, y compris de poissons en frai dans le banc Western et dans le banc Georges.

La présent article résume l'information sur les bancs au large du plateau Scotian et du banc Georges, y compris les débarquements historiques, les données récentes provenant des relevés réalisés par les navires de recherche et les données provenant de la flotte de pêche commerciale.

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INTRODUCTION

Offshore banks of NAFO subareas 4 and 5 have, in the past, supported significant herring (Clupea harengus) fisheries, particularly by foreign (European) vessels. Georges Bank was at one time the largest herring fishery in the western Atlantic and yielded some 2.7 million tonnes before its collapse in 1977. Herring fisheries also existed on offshore Scotian Shelf banks both west (4Wb) and east (4Vs) of Sable Island.

During the past decade, these fisheries have been inactive: foreign vessels have been excluded and domestic vessels have fished herring nearer the coast. In the case of Georges Bank, there has been, until very recently, no sign of stock recovery.

In the past few years, larger vessels of the Scotia-Fundy herring purse seine fleet have expressed interest in fishing, and have made occasional trips to search for, herring on offshore banks. These vessels, facing restriction by individual vessel quotas in the 4WX fishery and a short season (limited to the spawning period) due to the dominance of the roe market, are looking for fish which may be of different stock origin (i.e. fish other than 4WX stock and which may, therefore, result in additional quota). In addition, they have been attracted to the Emerald/Western Bank areas by reports of large fish which would suit a domestic bloater/fillet market.

Searches have been made in both spring and fall during the past couple of years, and in 1986 several significant findings were made, including spawning fish on both Western Bank and Georges Bank. In this paper, we summarize historical information concerning herring stock structure on offshore banks and historical landings from these fisheries. We present data from research surveys and recent trips by the commercial fleet to offshore banks, and chronicle the reappearance of the 1983 year-class of herring on Georges Bank.

A) Herring of offshore Scotian Shelf Banks: Another stock in the 4WX management unit?

History of the fishery

During the 1960's and 70's, there were two fisheries on Scotian Shelf banks; one centered on Banquereau Bank (4Vs) and the other west of Sable Island (Emerald Bank - 4Wb) (Fig. 1). Both were fished primarily by foreign (European) vessels.

Historical catches are difficult to assign to particular offshore areas because of changes in the aggregation of statistical data but a preliminary reconstruction (Table 1) shows that the two fisheries yielded over 100,000 t each in the late 1960's and early 1970's.

Stock structure

The prevailing view of the stock structure of the herring on offshore Scotian Shelf banks has changed. In 1971, these herring were thought to be overwintering aggregations from two stocks:

> "Evidence is accumulating that two distinct stocks overwinter on the Scotian Shelf, one in the

> Banquereau area (Div. 4V) and the other in the Emerald Bank - Middle Bank area (Div. 4W). Recent studies suggest that the Banquereau fish are related to those caught inshore in the Chedabucto Bay - Canso area (Div. 4W) and that they do not migrate to the Gulf of St. Lawrence."
>
> "It is possible that the herring exploited in the Emerald-Middle Bank area are over-wintering concentrations of the stock spawning off the southwest coast of Nova Scotia and this possibility is being investigated."
> (ICNAF Redbook 1971, p. 46).

The 1972 report of the ICNAF Herring Working Group stated:

> "USSR data confirmed that the herring fished on the Scotian Shelf in Division 4W in winter are members of the Nova Scotia stock which spawns in autumn off southern Nova Scotia (Div. 4Xa) and that this stock is distinct from the Banquereau stock."
> (ICNAF Redbook 1972, p. 43).

The Banquereau stock was considered to include fish from 4Wa and 4Vs. ICNAF summarized stock structure in the 1972 figure reproduced here as Fig. 2.

In the mid-1970's, the management unit boundaries were changed (ICNAF Redbook 1975). Tagging results from 1974 had indicated a strong connection between the Chedabucto Bay fishery (Div. 4W(a)) and the southwest Nova Scotia stock component. As a result, the 4WX management unit (actually 4XW(b)) was enlarged (Fig. 1) to include:

> "...Canadian catches off southwest Nova Scotia (Div. 4X(a)), the non-Canadian catches in Div. 4XW(b), as in the previous 4XW(b) assessment, the Canadian catches in Div. 4W(a) since 1969 when the fishery began, and the USSR catches in 1974 from Div. 4VW(a). Catches in earlier years from Subdiv. 4Vs were not included as they were assumed to be from the same stock as catches from Subdiv. 4Vn."
> (ICNAF Redbook 1975, p. 38).

This left Div. 4V to be managed separately.

Foreign fisheries in both 4Vs and 4Wb ceased, and the question of stock structure of herring from offshore banks was not pursued.

Recent activity by the commercial fleet

Spring 1985

A limited experimental fishery for herring was undertaken in conjunction with DFO during April 18-26, 1985 on offshore Scotian Shelf banks. The objective was to find and tag herring reported by groundfish draggers to be of larger size than fish in the commercial herring fishery and possibly of different stock origin. Three commercial purse seine

vessels searched Emerald, Western, Sable Island, Middle and Banquereau Banks but found little evidence of herring. A few sets were made on Middle Bank (Table 2) but no fish were landed or tagged.

Fall 1986

During 1986, vessels made trips to Western Bank in response to reports of herring from groundfish draggers. Herring were found, and several successful sets were made (Table 3). Fish were large (29-36 cm) and were 4 to 9 yr old (Fig. 3).

Research vessel surveys

The occurrence of herring bycatches in research groundfish surveys (conducted by DFO Scotia-Fundy Region on the Scotian Shelf) provides an indication of the distribution on offshore Scotian Shelf banks. Fig. 4 provides summaries of herring caught (numbers, total) in spring, and fall cruises of the Lady Hammond and Alfred Needler between 1978 and 1985. The spring data (Fig. 4b) show a more or less continuous occurrence of herring bycatches from Western Bank west through Baccaro Bank and Browns Bank and around to the mouth of the Bay of Fundy. Relatively few herring were taken on Sable Island and Banquereau Banks in the spring surveys.

Fall surveys (Fig. 4d) show an aggregation of herring on Western and Sable Island Banks - in the same area in which spawning fish were taken in 1986 commercial sets.

Management considerations - Scotian Shelf banks

Herring taken on outer Scotian Shelf banks have been larger (and older) than those of the usual 4WX fishery. Groundfish research survey data indicate a discrete aggregation on the Western/Sable Bank area in the fall - and the discovery of "ripe and running" fish there in 1986 indicates a discrete spawning unit. On the other hand, spawning had not been documented in the area previously, and the presence of egg beds and larvae has not been verified. We have no information on the size of this group of fish or of its distribution at other times of the year. Length frequencies of herring taken in the spring groundfish trawls from outer banks are similar to those taken in the fall and indicate possible affinity.

B) Reappearance of spawning herring on Georges Bank: Stock recovery or recolonization?

A fishery for herring on Georges Bank began in 1961, and grew rapidly to become the largest herring fishery in the northwest Atlantic. Landings by a multinational fleet, using a variety of gear types, increased to 374,000 t in 1968 but subsequently declined. Catches in excess of 100,000 t were maintained until 1975 but the fishery then crashed. Only 2000 t were taken in 1977 and the fishery has been economically extinct since. The fishery followed a classic "boom and bust" pattern which yielded about 2.7 million tonnes of herring between 1961 and 1976 (Table 4).

There were almost no signs of herring on Georges Bank for almost a decade. In 1986, however, there were several reports of herring, including fish in ripe and running condition taken in research vessel tows (Table 5,

Fig. 5). The herring were almost exclusively 3-yr-old, presumably spawning for the first time.

The reappearance of spawning herring on Georges is of considerable scientific interest in several ways. First, it represents a critical test of hypotheses concerning herring stock structure; in particular, of the discrete-stock concept. There has been debate concerning the integrity or fidelity of spawning components (or stocks) of herring.

Recent papers point to a dilemma. Regularity of spawning (both geographic and temporal), tag evidence for homing, differential population dynamics of neighbouring groups and larval retention all indicate that spawning units are genetically distinct (as for example in Iles and Sinclair 1982, Cushing 1968, and others). On the other hand, the lack of differences in genetic (particularly allozyme) studies and weak results in traditional stock identification studies have been interpreted as indicating a significant amount of gene-flow between neighbouring spawning aggregations; and to the argument that the herring stock is an artificial subdivision of a larger population, and has no taxonomic or evolutionary status (Smith and Jamieson 1986). In this regard, the reappearance of herring on Georges Bank raises the obvious question -- is it the result of resurgence of the historical (genetically unique) Georges stock; or replacement by herring from a neighbouring spawning aggregation? The implications of this question are critical to our perception of stock structure.

A second area of scientific interest concerns the timing of the crash and the reappearance. The disappearance has been attributed to overfishing combined with poor recruitment (e.g. Anthony and Waring 1980). What mechanisms led to/allowed the reappearance of what is apparently a single (1983) year-class? Why did the reappearance take so long?

The reappearance of Georges Bank herring is also of considerable socio-economic interest. This was once the largest herring fishery in the area; how large a fishery might it support in the future? In addition, the Georges Bank stock was hypothesized to have contributed juveniles to the coastal Maine and New Brunswick weir fisheries. Might the reappearance of this stock lead to an improvement in the current trend of low weir landings?

Summary of the Historical Fishery

Anthony and Waring (1980) have summarized statistical information from the historical Georges Bank fishery; and their account follows. Table 4 lists landings from the Georges Bank historical fishery by country.

> "In 1961 the USSR began the first intensive fishery for large herring on Georges Bank and landed 68000 t of herring in the first year of operation (Table 2). From 1961 to 1966 the USSR was the only nation harvesting the herring stock in significant quantities. Heavy fishing did not develop until 1967 when several other nations began intensive

fishing operations. The Soviet Union diverted their effort from herring and began fishing for silver hake in 1963 and 1964 and for red hake and haddock in 1965. The catch of hake and haddock by the USSR in 1965 and 1966 totaled 422000 and 371000 t, respectively. The catch of herring by the Soviet Union in 1965 was only 36300 t, although herring were very abundant."

"Poland began intensive fishing for herring on Georges Bank in 1966, landing 14000 t (Table 2), and by 1968 the catch had increased sharply to 75000 t. The Federal Republic of Germany (FRG) entered the fishery in 1967 with a small catch, but in 1968 their catch was nearly as great as that of Poland. The German Democratic Republic (GDR) also began fishing operations for herring on Georges Bank in 1967. Subsequently, herring on Georges Bank were harvested by the U.S., Canada, USSR, Poland, FRG, GDR, Romania, Iceland, Japan, Norway, Bulgaria, and Cuba (Table 2)."

"Gill nets were used extensively by the Soviet Union during the first three years of the fishery. In 1961, 216386 gill nets were used and in 1962 and 1963, 1105566 and 106079 nets were used, respectively. Although pair trawling was tried in 1964, the bottom-fished otter trawl was the major gear type used by the Soviet Union from 1964 to 1968. In 1968 the USSR introduced purse seines into the fishery. This gear caught an average of 18000 t or 23% of the Soviet catch during 1968-1976. Until the introduction of midwater trawling by the GDR in 1971, side and stern bottom-fishing trawlers were the dominant vessels in the fishery (Fig. 4). The side trawlers were primarily smaller than 900 GRT and the larger stern trawlers fished with otter trawls on the bottom until about 1972 when a change to midwater gear occurred. The catch of purse seines increased steadily from 1970 to 1975 and then sharply declined. The shift to mid-water trawling may have resulted, in part, from reduced ICNAF quotas on demersal fish stocks."

"The shift in effort in 1965 and 1966 (Fig. 4) between the side and stern trawlers resulted from a shift of effort by the Soviets onto the large haddock and hake stocks which were fished by the large stern trawlers. The catch of herring may have been only a by-catch."
(Anthony and Waring 1980, p. 74-76).

Reappearance of herring

Surveys on Georges Bank both for herring (larval surveys mostly) and other species (e.g. groundfish research surveys) showed the absence of herring from Georges from 1977 to 1984 (see, for example, Smith and Johnson 1986). Since 1984, however, there have been several instances of herring taken on Georges Bank (Table 5). These fish have invariably been of the 1983 year-class and were taken in spawning condition for the first time in the fall of 1986 (Fig. 5).

Biological characteristics of the new Georges Bank herring

The herring taken in the autumn of 1986 were almost all age 3 and had a modal length of 26 cm. These characteristics alone indicate a different group of fish than is present in neighbouring stocks (Figs. 6 and 7) and support the resurgence hypothesis. An extensive stock identification project involving morphometric, meristic, parasite, enzyme and mt-DNA analyses is being undertaken. It is based upon two comparisons:

i) Current Georges Bank fish with current neighbouring populations.

ii) Current Georges fish with literature values for historical Georges fish.

Management considerations - Georges Bank

The appearance of fish of the 1983 yearclass should be tentatively interpreted as resurgence of the Georges Bank stock and research on this apparent recovery should be encouraged. It must be stressed that only traces of herring have been seen (111 individuals from the fall groundfish survey) and no fishing should be allowed until there is evidence of a substantial stock size, and due consideration has been given to the association with the coastal juvenile (weir) fishery. This stock is recognized as being transboundary (between the USA and Canada) and consistent management measures should be sought.

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Table 1. Historical herring landings ('000 t) from Scotian Shelf banks.

Area	Year	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	Source
4Wb				3	1	6	2	1	2	13	60	29					ICNAF Redbook 1972, Part 1, p. 48
				3.0	2.5	5.9	2.5	.6	2.8	14.6	59.9	24.3					Miller 1973
													23				ICNAF Redbook 1973, p. 33
													15.5	13.2			ICNAF Redbook 1974, p. 39
	Avg. Total			3	2	6	2	1	2	14	60	27	19	13			
4Vs									16	107	27	1					ICNAF Redbook 1972, Part 1, p. 48
													1				ICNAF Redbook 1973, p.33
													2.4	.9			ICNAF Redbook 1974, p. 39
	Avg. Total								16	107	27	1	2	1			

Table 2. Summary of sets made in the experiment (spring) 1985 offshore Scotian Shelf herring fishery.

Date	Vessel	Location	Notes
21/4/85	Margaret Elizabeth	44°35'N 60°20'W	Large school est. 2000 t. Tore net - no catch.
		44°34'N 60°19'W	Large school. Fish too close to bottom - no catch.
21/4/85	Canada 100	44°34'N 60°19'W	Large concentrated school dispersed while setting, twice. Very small catches released. Fish 20-36 cm in length; modal length 31.
23/4/85	Mattuna Mariner	44°38.5'N 60°21.5'W	Catch 15 t. Fish full of red feed - released. Bimodal length distribution; modes at 22.5 and 28.5 cm.

Table 3. Summary of sets made by herring purse seiners on Western Bank, Oct. 1986.

Vessel	Date	Time	Location	Catch (short tons)	Notes
Island Pride	2/10	21:00	43°36.48'N 61°37.00'W	30	Very large fish; very good roe
	2/10	23.00	As above	40	"
	3/10	04.00	As above	60	"
Lady Melissa	2/10		(5930) 13617.7 29236.7	70	Big roe fish
	2/10		(5930) 13618.7 29225.7	70	"
Mari Lynne Anita	2/10	21:00	43°56'N 61°38'W	0	
		23:00	As above	20	
	3/10	2:30	As above	70	
		5:30	As above	20	
Mattuna Mariner	2/10	20:00	43°49.30'N 61°37.00'W	1	Fish deep; small catch released
		21:10	43°49'N 61°38'W	70	Lots of big fish; good roe

Table 4. Historical record of herring landings from Georges Bank (1961-1977): From Anthony and Waring 1980, p. 75.

Year	USA	Canada	FRG	GDR	USSR	Poland	Japan	Bulgaria	France	Iceland	Norway	Romania	Cuba	Others	Total
1961..	105	–	–	–	67 550	–	–	–	–	–	–	–	–	–	67 655
1962..	101	–	–	–	151 864	277	–	–	–	–	–	–	–	–	152 242
1963..	322	–	–	–	97 646	–	–	–	–	–	–	–	–	–	97 968
1964..	489	–	–	–	130 914	35	–	–	–	–	–	–	–	–	131 438
1965..	1 191	–	–	–	38 262	1 447	–	–	–	–	–	1 982	–	–	42 882
1966..	4 308	–	–	1 133	120 113	14 473	–	–	–	–	–	2 677	–	–	142 704
1967..	1 211	1 306	28 171	22 159	126 759	36 677	40	–	–	–	–	1 420	–	–	218 743
1968..	758	13 674	71 086	67 719	143 097	75 080	171	–	–	292	–	1 656	–	65	373 598
1969..	3 678	945	61 990	44 624	138 673	45 021	583	812	–	12 786	1 224	337	–	85	310 758
1970..	2 011	7	82 498	28 063	61 579	70 691	1 412	348	–	–	–	685	–	–	247 294
1971..	3 822	12 863	54 744	18 447	81 258	88 325	2 466	4 551	–	–	–	898	–	–	267 374
1972..	2 782	53	27 703	40 016	48 072	49 392	1 161	2 355	500	–	–	2 156	–	–	174 190
	(4 000)	(5 800)	(31 600	–	(48 200)	(49 400)	(200)	–	–	–	–	(600)	–	(8 200)	(150 000)
1973..	4 627	5 083	31 501	53 326	52 340	49 275	1 722	1 380	2 784	–	–	297	–	–	202 335
	(5 250)	(5 050)	(31 600)	–	(48 200)	(49 400)	(1 200)	–	–	–	–	(1 300)	(8 000)	–	(150 000)
1974..	3 370	217	23 690	31 530	41 541	39 312	4 242	1 773	3 617	–	–	2 018	–	–	149 510
	(6 955)	(2 980)	(23 900)	(31 440)	(41 725)	(39 000)	–	–	–	–	–	–	(4 000)	–	(150 000)
1975..	4 582	0	22 957	30 901	40 945	38 392	1 878	421	3 304	–	–	1 544	10	1 162	146 096
	(8 400)	(3 000)	(23 750)	(31 150)	(41 100)	(38 400)	–	–	–	–	–	–	(4 200)	–	(150 000)
1976..	744	–	8 806	7 891	12 996	10 517	868	103	1 166	–	–	115	296	3	43 507
	(12 400)	(1 000)	(9 200)	(9 300)	(12 190)	(11 000)	(1 100)	(900)	(1 100)	–	–	(800)	(10)	(1 000)	(60 000)
1977..	361	2	–	–	1 492	119	–	1	–	–	–	–	152	–	2 127
	(12 000)	(1 000)	(4 725)	(4 825)	(3 400)	(5 100)	–	(100)	(1 000)	–	–	(100)	(50)	(700)	(33 000)

[a] National allocations in parentheses.

Table 5. Recent evidence of the reappearance of herring on Georges Bank.

Date	Observation	Notes
Oct. 29-Nov.5/86	Adult herring some spawning taken in research survey (Canada)[1]	Alfred Needler cruise No. 71. 111 herring taken as bycatch in groundfish sets. Almost entirely age 3; length = 26.9 ± 1.3 cm. Location NE peak, (along 50-fath contour). Fig. 5.
Oct. 14-Oct. 24/86	Adult herring taken in U.S. research survey[2]	Albatross cruise 86-05 (II). 43 herring taken as by catch in groundfish sets. All age 3. Location; northern edge.
May 19-May 20/86	Successful set by commercial purse seiner[3]	Lady Melissa. Approx. 2 t and 60 t taken in two sets. Fish feedy.

Date	Time	Lat.	Long.	Catch	Length (mean)
19/5	23:30	42 04	66 30	2 t	25.0
20/5	9:00	42 05	66 35	68 t	24.0

Mar. /86	Adult herring taken in spring groundfish survey (Canada)[1]	Alfred Needler cruise No. 59. 786 herring taken as by-catch in groundfish sets. Length range 15-26 cm (mean = 19.5 cm).
Feb. 24/86	Adult herring taken in U.S. groundfish survey[2]	Delaware cruise 86-02. 213 herring all age 3 (83 YC) at 4 stations (37-40) around 41°49' 66°50'. As by-catch in groundfish sets.
June 12/84	Small juveniles taken in midwater research survey[4]	Alfred Needler cruise No. 29. 42°02' 66°59'. 20:21 hr 12/6/84. IYGYPT midwater trawl at 60 m. Mean length = 60.5 mm. 1983 YC.

[1]MFD Groundfish Survey Data, DFO, St. Andrews, ; [2]V. Anthony, NMFS, Woods Hole, pers. comm.;
[3]R. Stephenson, DFO, St. Andrews, unpubl. data; [4]J. Neilson, DFO, St. Andrews, pers. comm.

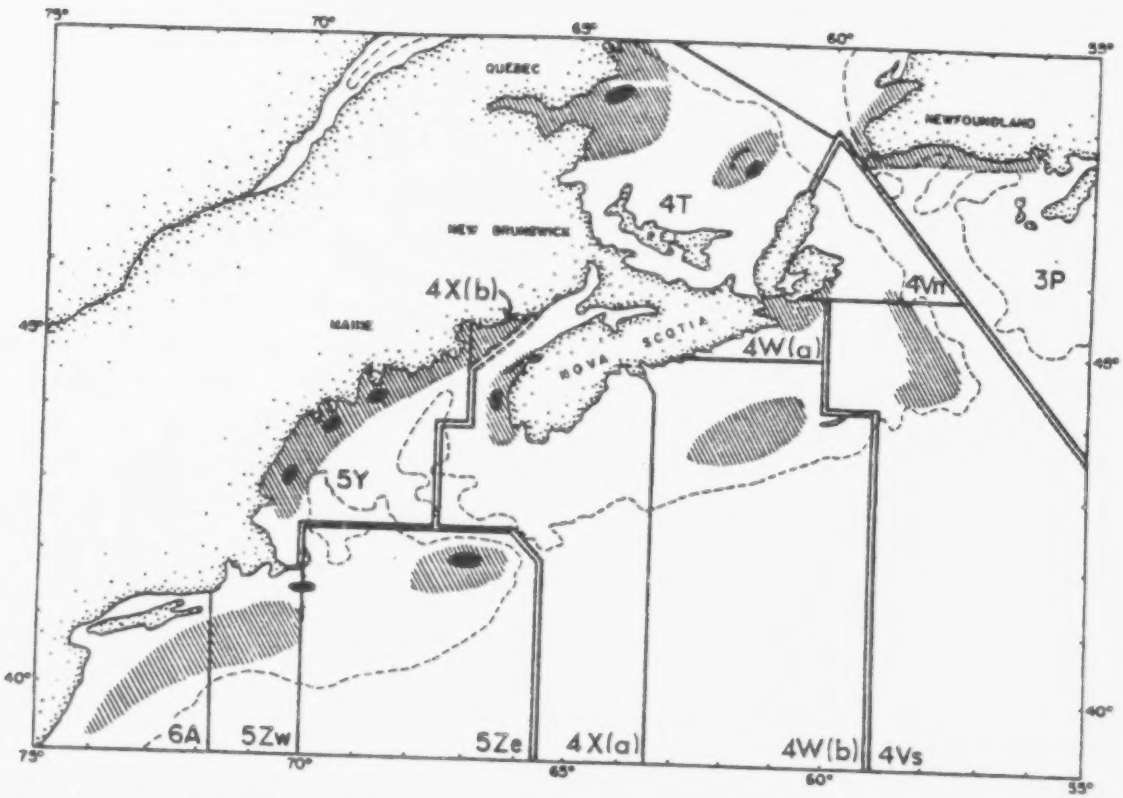


Fig. 1. Herring stock structure in Subareas 4 and 5 and Statistical Area 6. (Double lines indicate stock management areas; solid black areas indicate the general spawning grounds.)

Fig. 1. 1976 ICNAF figure of herring stock structure showing locations of historical offshore fisheries in areas 4Vs and 4Wb. Source: ICNAF Redbook 1976, p. 36.

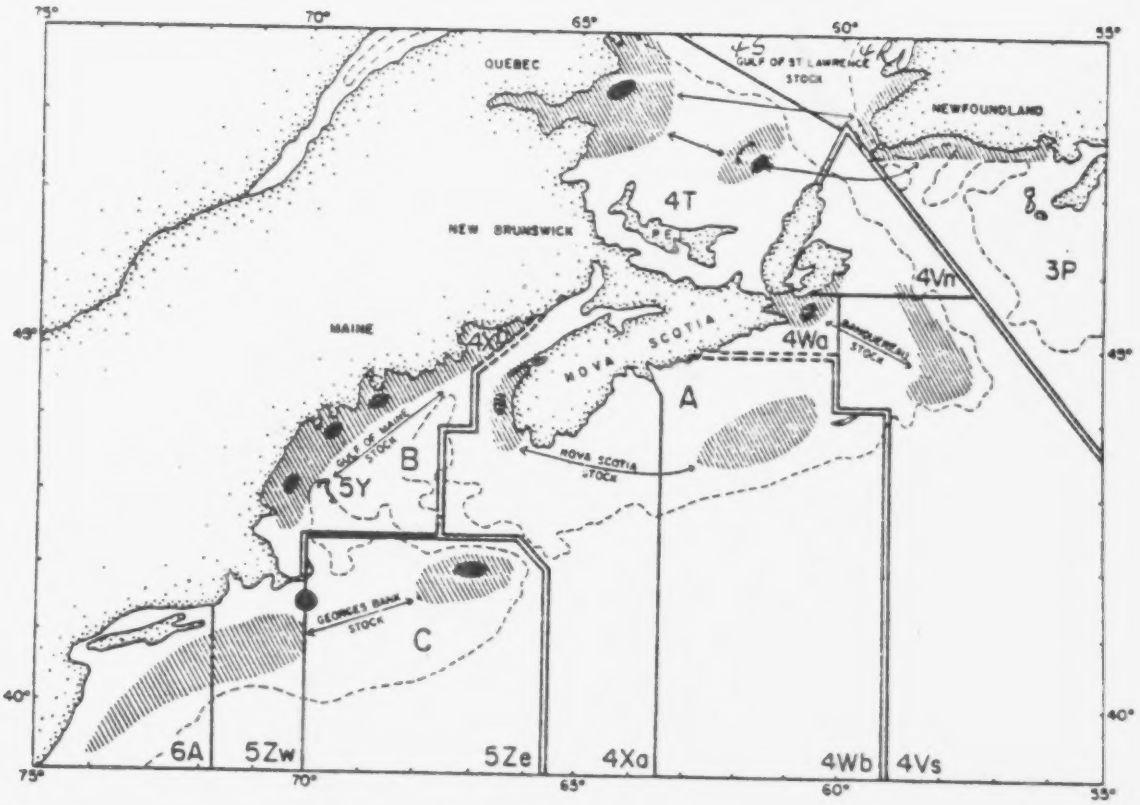


Fig. 1. Herring stock structure in the ICNAF Area (double lines indicate stock boundaries and the solid black areas indicate the general spawning grounds).

Fig. 2. 1972 ICNAF view of herring stock structure.
Source: ICNAF Redbook 1972, p. 62

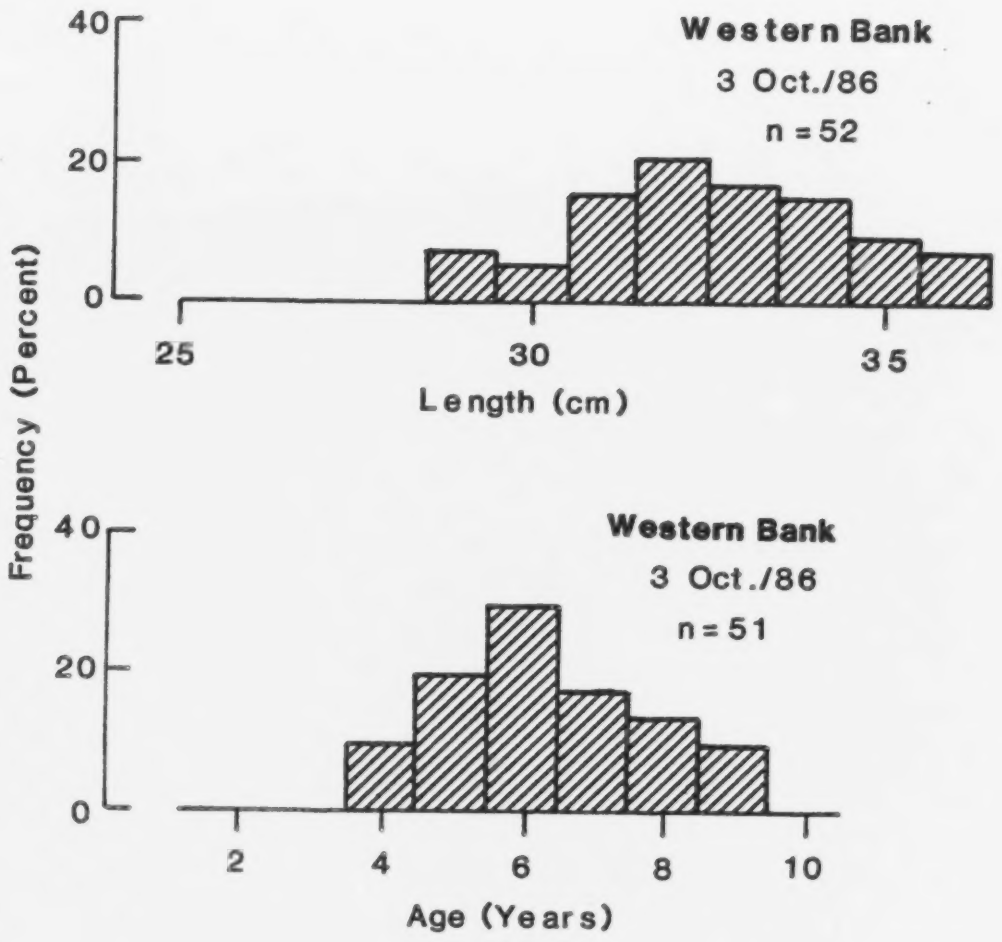


Fig. 3. Age and length frequencies for herring caught on Western Bank, Oct. 3, 1986.

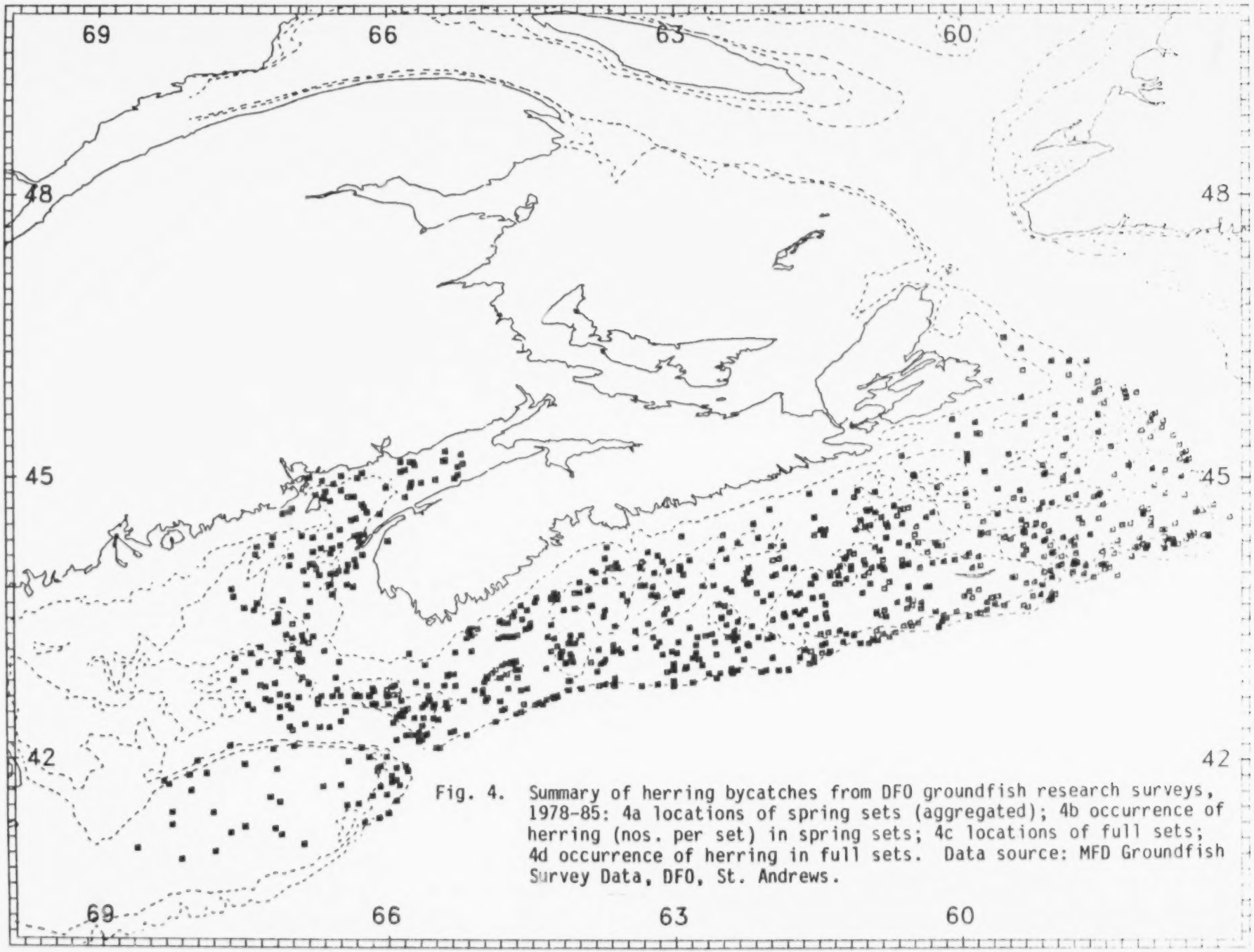
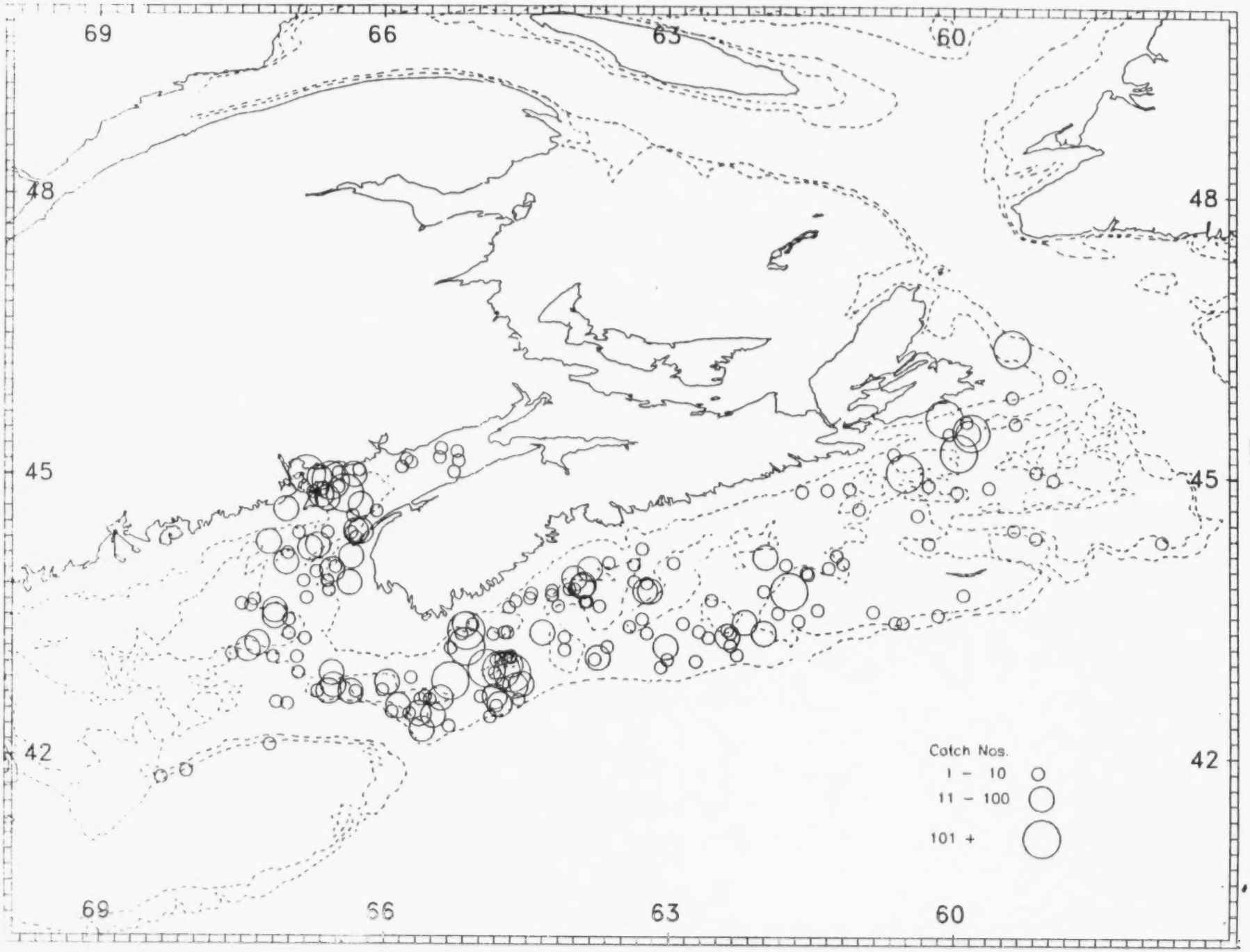
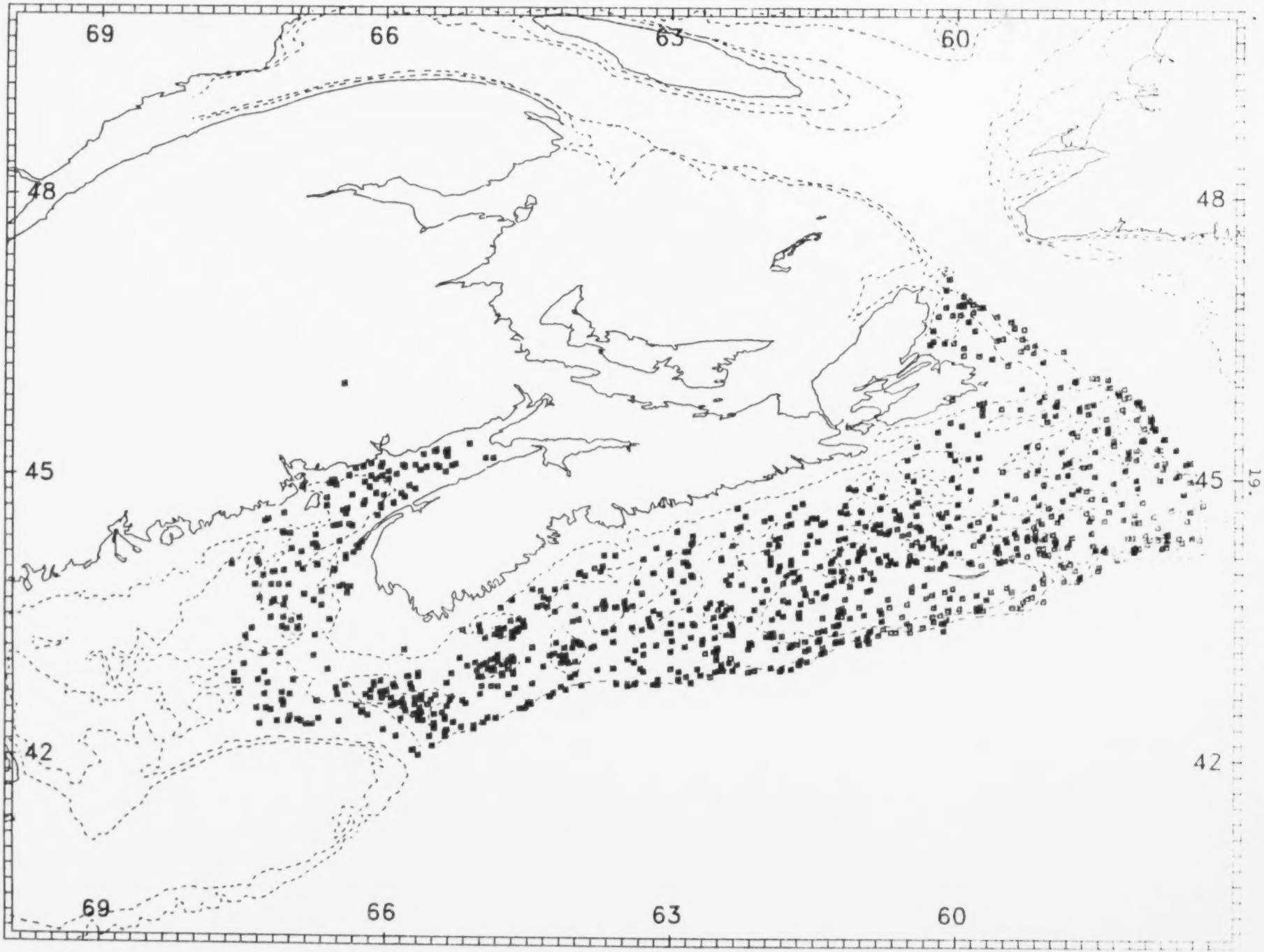


Fig. 4. Summary of herring bycatches from DFO groundfish research surveys, 1978-85: 4a locations of spring sets (aggregated); 4b occurrence of herring (nos. per set) in spring sets; 4c locations of full sets; 4d occurrence of herring in full sets. Data source: MFD Groundfish Survey Data, DFO, St. Andrews.

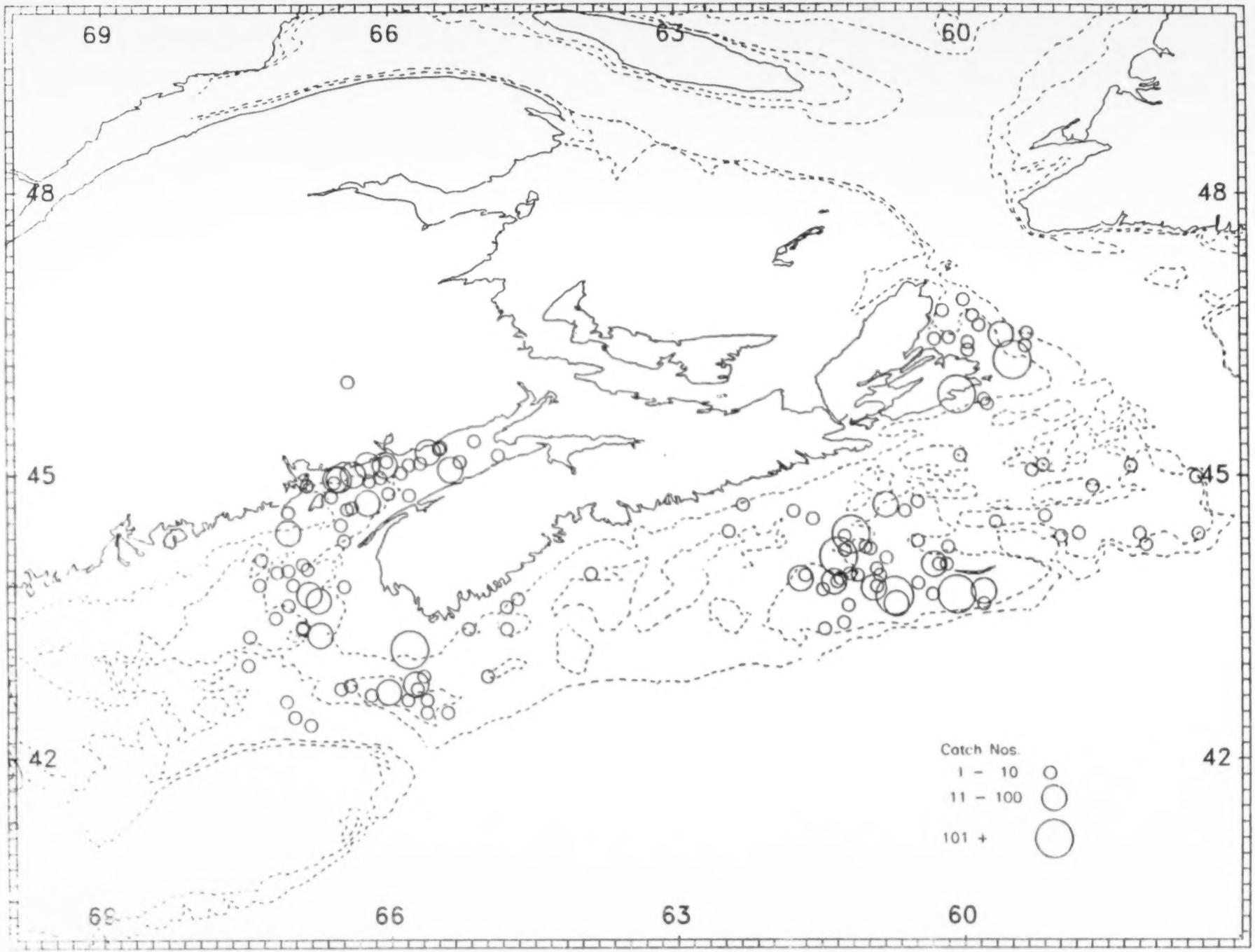
Herring Catches from SPRING Groundfish Data



Station Locations for FALL Groundfish Data



Herring Catches from FALL Groundfish Data



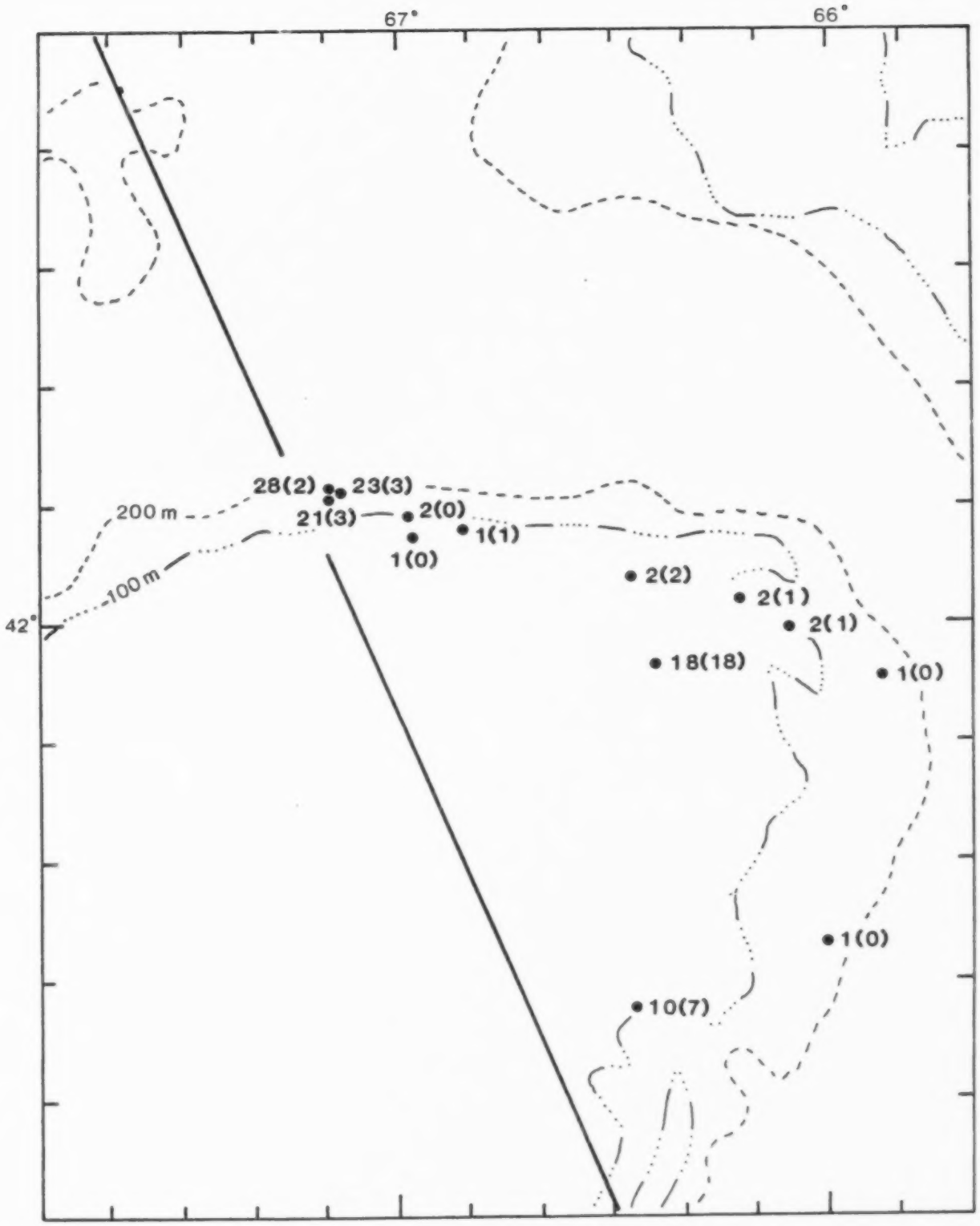


Fig. 5. Occurrence of herring (numbers; with number in spawning condition in brackets) in groundfish research survey sets on Georges Bank: Alfred Needler cruise N071, autumn 1986.

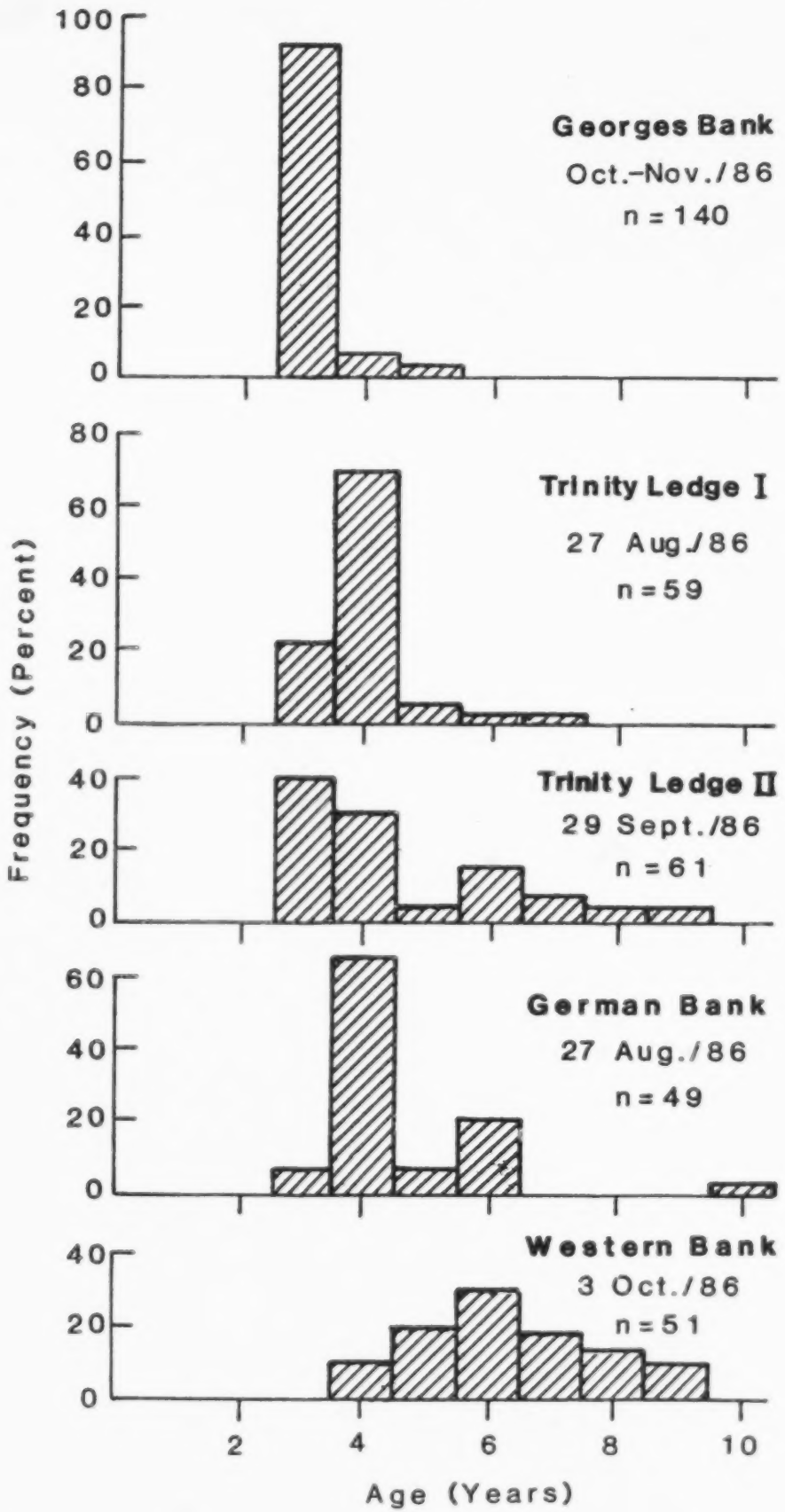


Fig. 6. Age composition of samples from Georges Bank and from neighboring spawning groups.

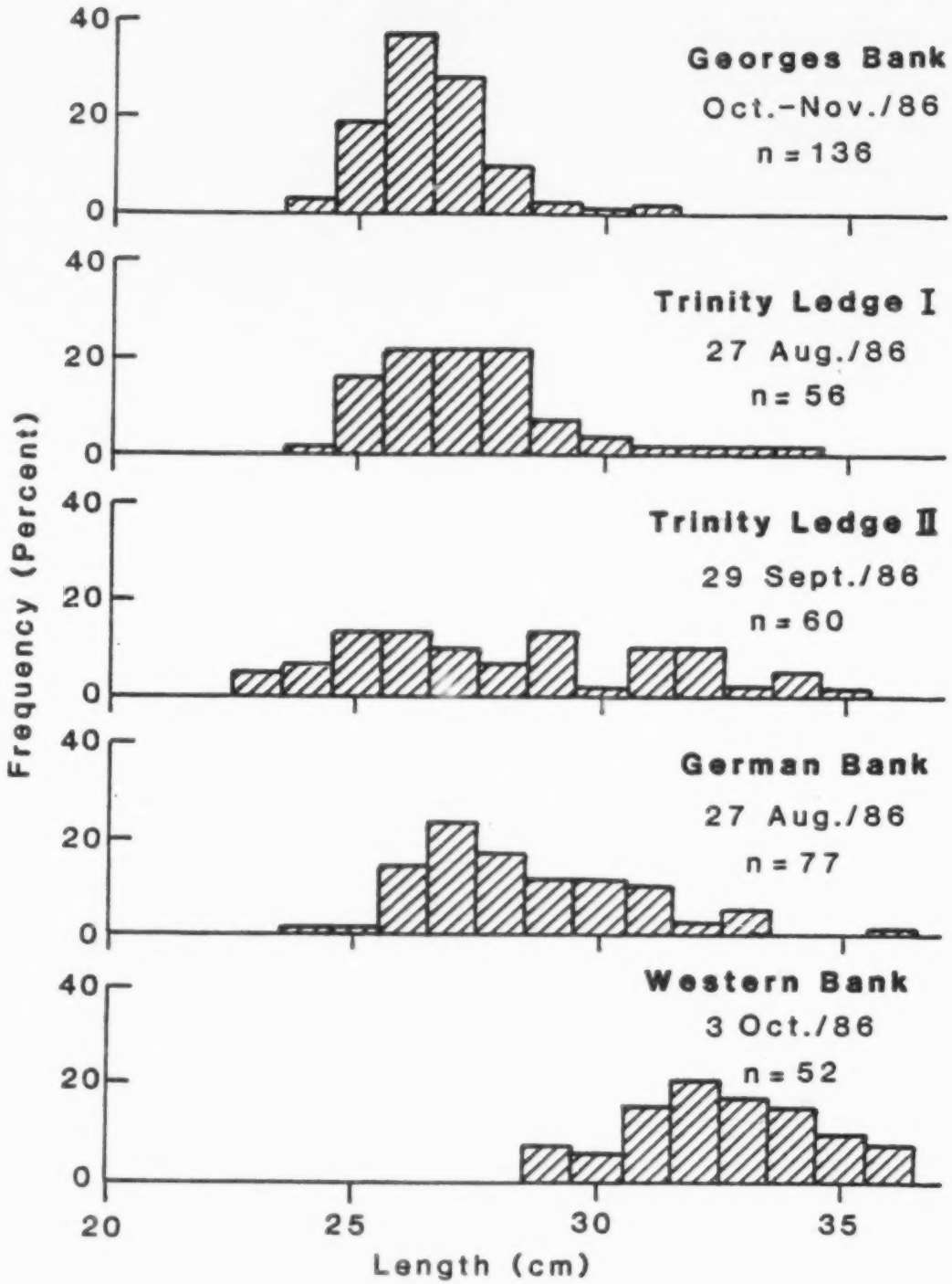


Fig. 7. Length-frequency composition of Georges Bank samples compared with those from neighboring spawning groups.